The Implicit and Explicit Processing of the Facial Expression of Emotion in the Healthy Aging Adult

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Abstract

Elderly individuals are consistently reported as having difficulty in identifying the facial expression of negative emotions; they pay less attention to negative emotional stimuli, and experience less emotion themselves when compared to younger adults. The ability to process emotion is thought to be critical for communication with others and yet, despite the claims above, healthy-aging older adults do not appear to demonstrate interpersonal problems in their everyday lives. Therefore, although older adults are significantly worse at explicitly labelling emotions compared with younger adults, it may be that they are still able to implicitly identify the emotions and therefore adapt their behaviour accordingly. This study aims to determine the healthy aging adults' ability to explicitly and implicitly process the facial expression of emotion. Analysis was undertaken to determine which specific emotion the older group had difficulty with when asked to identify the implicitly presented emotion, whether the position of the presentation of the photograph had any influence, the role of social contact on performance, and whether, in-keeping with previous research, the older group had significant difficulty correctly identifying the explicitly presented facial expressions of emotion when compared with the younger group.

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Keywords

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Index

Introduction and Literature Review

1.0 Introduction

Interest in this research project grew from awareness that elderly individuals were consistently reported as having difficulty in identifying the facial expression of negative emotions, they pay less attention to negative emotional stimuli, and experience less emotion themselves when compared to younger adults (Mather et al, 2004). The ability to process emotion is thought to be critical for communication with others (Surcinelli et al, 2006) and yet, despite the claims above, healthy-aging older adults do not appear to demonstrate interpersonal problems in their everyday lives. Therefore, although older adults are significantly worse at explicitly labelling emotions compared with younger adults, it may be that they are still able to implicitly identify the emotions and therefore adapt their behaviour accordingly. In line with this hypothesis, studies have shown that older adults' implicit processing is often not affected by age (Parkin, 2001).

The aim of this study is therefore to assess the ability of the healthy aging adult in the processing of the explicit and implicit facial expression of emotion.

1.1 Emotion and the importance of emotion

It has long been argued that there is a biological basis to emotion (Ekman, 1992), and many agree with an evolutionary foundation as posited by Darwin (1965).

A public argument ensued when Ortony and Turner (1990) questioned whether there were in fact basic emotions. They claimed there was a lack of empirical or theoretical standing for the argument that all emotions were developed from the basic six emotions. In a table they listed a number of authors with an interest in a basic-emotion theory. Many of these emotions are not part of the postulated six, for example aversion, courage, desire, and pain. The number of basic emotions suggested varies from two to eleven. They then argue that this lack of consistency of the number of basic emotions hampers further development in the research of the expression of emotion. Ekman (1992) then challenged their assumptions on the basis of their review of the literature being faulty, and making false claims. In response Turner and Ortony (1992) stated that as critics of their stance each began at a different starting point in their own research, it would not be probable for there to be a convergence on views.

In 1995, Rosenberg and Ekman claimed that for more than forty years there had been an overwhelming amount of evidence to support the assertion that there were universally recognised facial expressions of emotions. These were anger, disgust, fear, happiness, sadness, and surprised. Studies reviewed were those undertaken in both literate and pre-literate cultures and some had cross-cultural evaluation. Not all researchers agreed, but it is now generally accepted there are universal expressions of emotion. These expressions of emotion include anger, contempt, sadness, happiness, surprise, disgust, and fear/anxiety (Matsumoto & Ekman, 2004). There is no consistent agreement on whether contempt is actually accepted as one of the six basic emotions. Some authors use contempt in their studies, although this is not one of the original six basic expressions of emotion. Additionally, this expression is frequently confused with happiness, fear and disgust (Rosenberg and Ekman, 1995) and so will not be used in this study.

The facial expression of emotion can involve quite a complex number of facial muscles which, when used in differing combinations, can signal different emotions (Ekman, Fiesen, and Ellsworth, 1972). For example, the zygomatic muscle can act alone to indicate happiness by pulling up the lip corners, but when acting with other muscles it can signal sadness. Ortony and Turner (1990) argued each facial muscle had universal significance. Ekman (1992) said not so. However, he did note it only takes one muscle action to display the expression disgust, and one other to display the emotion of happiness. Perhaps this helps in understanding why these two emotions are said to be easily recognised. It may be that as the other facial expression of emotion requires the action of more than one muscle, this may lead to individual differences and so possibly lead to mislabelling by the observer. Waller, Cray, and Burrows (2008) however, question the model of universality on the basis that in order for the facial expression of emotion to be universal, every individual would have to have the same facial musculature and symmetry, and, they argue, they do not.

The length of time for which an emotion is displayed may vary. The expression of emotion can have a quick or slower onset, and may be displayed for a very brief moment or maintained for some length of time (Ekman, 1992). The onset and maintenance of the facial emotional display can signal the intensity of the emotion, but it is also important to note that facial expression can occur without the displayer actually feeling the emotion displayed (Ekman, 1992).

Further support for a biological basis of emotion was provided by Ekman, Levenson and Friesen (1983) who identified emotion-specific autonomic nervous system activity. These findings were later replicated in an older population (Levenson, Carstensen, Friesen and Ekman, 1991) and cross-culturally (Levenson, Ekman, Heider, and Friesen, 1992). Ekman (1992) argues these findings show a particular pattern of activity restricted to those emotions such as anger, fear and disgust, which when stimulated, may require motor activity relevant to survival. Other emotions, he contends, will have their own pattern of activity.

Emotion is something most of us can claim to experience – either as a feeling within ourselves or as an observation within others. Time and again the social role of emotion is emphasised, with Taylor, Edmonds, McCarthy and Allison (2001) stating faces and their expressions are the most important visual stimuli for individuals in their social interactions. Adolphs (2002) refers to the facial expression of emotion as emotional signals, and states they may be considered as aspects of both an emotional response and social communication. Moreover, whilst Lobaugh, Gibson, and Taylor (2006) stress the significance of the processing of the emotions in social interactions, Vassallo (2009) asserts it is the ability to interpret the facial expression of emotion that plays an important role in interpersonal interactions.

Ekmann (1992) emphasises the importance of the facial expression of emotion throughout life. They are involved in attachment in infancy and indeed in adult attachment (courtship). There is evidence to show that where individuals have no ability to make a facial expression of emotion, they have difficulty with establishing and maintaining relationships. Evidence for those with difficulty with recognition of the facial expression of emotion is considered further in Section 1.3.

Conversely, perhaps the recognition of the facial expression of emotion is not terribly complicated as acknowledged by Mill, Allik, Realo and Valk (2009) when they refer to the expression and recognition of emotion as being two basic skills in normal social interaction. However, whether innate, basic or complicated, the ability to recognise the facial expression of emotion is important in every day life as it will inform how an individual should react towards another and whether it is necessary to alter their own behaviour in response to the emotions of others.

If the recognition of the facial expression of emotion is innate, biological and be important to survival in evolutionary terms, then we would expect to have evidence of the ability from an early age. We shall now move on to consider this evidence.

1.2 Emotion recognition through the ages

Given that there is a strong argument for a biological, innate basis to the recognition of the facial expression of emotions, one would expect to see evidence for this in those as young as babies and infants. Herba and Phillips (2004) demonstrated a child's ability to evaluate and correctly interpret the facial expression of emotion follows a very slow developmental course, which continues through adolescence. This actual development however, has been shown to be efficient in individuals as young as seven months old. Peltola, Leppänen, Vogel-Farley, Hietanen and Nelson (2009) found in their study that seven-month-old infants show adult-like attentional biases toward fearful faces. The infants scanned the eye area more than other regions of the face, in keeping with the findings of four- to fifteen-year-olds (Taylor, Edmonds, McCarthy and Allison, 2001) and in adults (Schyns, Petro, & Smith, 2007). They tended to remain fixated on fearful faces, in comparison to happy and neutral faces. This enhanced fixation of fearful faces was also shown in adults (Georgiou, Bleakley, Hayward, Russo, Dutton et al, 2005). Although Yang, Zald, and Blake (2007) propose this would be as a result of simply detecting fearful eyes alone, Peltola et al (2009) found the infants in their study disengaged from neutral faces with fearful eyes quicker than fully fearful faces, thus perhaps emphasising the importance of information from more than the eye region.

Lobaugh, Gibson, and Taylor (2006) undertook a functional magnetic resonance imaging (fMRI) study in ten to twelve year old children, whereby they were presented with faces displaying the six basic emotions for 500 ms and they were then asked to determine the sex of the presented face. The results showed children of this age activated similar areas of the brain as adults do in response to being shown the emotional expressions without explicit attention to the emotion. These areas included the insula, anterior cingulate, basal ganglia and limbic structures, all identified as important in emotion expression processing (Adolphs, 2002a). They also suggest their results show that the implicit discrimination of facial expressions of disgust and fear are accomplished by age ten years. The children are activating different neural networks for sad faces, as also evidenced in adults. However, Batty and Taylor (2006)

suggest a more staggered developmental path with the neural processing in the younger children differing to that of adolescents, and the adult pattern appearing in the adolescents.

Once the ability to discriminate different facial expressions of emotion is established in adulthood, it is not maintained for life. Many studies have demonstrated that older adults have increasing difficulty with correctly identifying negative emotions. However, there appears to be no consensus as to the age at which this decline in the ability to identify negative emotions begins.

In a cross-sectional study Mill, Allik, Realo and Valk (2009) considered emotion recognition in static photographs, or slides, and in speech, in 607 participants aged 18 to 84 years. The emotions portrayed were anger, contempt, disgust, fear, happiness, sadness, and surprise and the neutral expression. Participants were simply asked to make a choice from a list, which emotion was being displayed in the slide. The slides were each shown for 10 s. The mean recognition rate of facial expressions was 70%. The younger age group (aged 20 years or less) were better at recognising sadness and anger, and indeed there was a significant negative linear correlation with age. The oldest age group (aged 61 years or older) performed at less than chance level with these emotions. The ability to recognise all of the other emotions remained almost constant until age 61 years when there was a considerable drop in ability. Correctly labelling the neutral expression was almost constant over all the age groups. All age groups were best at identifying happy expressions then surprise expressions. Further examination of the data revealed that when broken down into two age groups (younger and older) both confused emotion categories in a similar way, but the older group made more errors. The authors also concluded that personality traits as rated by the NEO-FFI were not significant mediators of age-related effects in emotion recognition.

Mill et al's study (2009) was notable for demonstrating that the ability to correctly recognise the expressions of sadness and anger was actually declining from, what they describe as, an unprecedentedly early age, the fourth decade.

Kelly, Quinn, Slater, Lee, Gibson et al (2005) showed that babies as young as three-months old have a preference for their own race faces, but this discrimination is absent in newborns. They suggest the preference is learned and derived from exposure to own- versus other-race faces during early development. Further support for this explanation is offered by Elfenbein

and Ambady, 2003 who suggest the modulation by race or ethnicity may be determined by experience. Phelps et al (2000) and Jugenberg and Bodenhausen (2003), also suggest there may be a bias effect to own-race versus other and this is evidenced by the underlying neurobiology of face processing (Hart et al, 2000; Phelps et al, 2000; Golby et al 2001; Lieberman et al, 2005). As a consequence of this, some research batteries of the facial expression of emotion have pictures of models of races and ethnicities other than Caucasian individuals.

Having shown some abilities are evident from birth, we shall now consider how this identification is made.

1.3 Emotion identification

In common with other areas in the field of neuropsychology, a great deal of evidence for the identification of the facial expression of emotion has arisen from studying those with brain lesions, disease or injury. However, as Adolphs (2002b) states, as there are many methods of investigating the facial expression of emotion, there are many explanations. There is therefore not one system or structure involved.

Difficulties in recognising the facial expression of emotion has been described in many neurological and psychological diseases. There is strong evidence that people with Huntington's disease, or gene carriers for the disease, are selectively impaired in recognising the facial expression of disgust (Sprengelmeyer, Young, Calder, Karnat, Lange et al, 1996; Sprengelmeyer, Young, Sprengelmeyer, Calder, Rowland et al, 1997; Gray, Young, Barker, and Curtis, 1997), whilst the recognition of this particular emotion appears to be selectively spared in adults with relatively mild Alzheimer's disease (Henry, Ruffman, McDonald, O'Leary, Phillips et al, 2008). Those participants in Henry et al's (2008) study with mild Alzheimer's disease did perform at a poorer level on all other facial expressions of emotion when compared with both older and younger control groups. An earlier study of participants with mixed dementia described poor recognition of the emotions of anger, sadness and fear (Rosen, Wilson, Schauer, Allison, Gorno-Tempini et al, 2006).

There are inconsistent reports of deficits in recognising the facial expression of emotion in individuals with Parkinson's disease. Some authors have reported general deficits (Yip, Lee,

Ho, Tsang, and Li, 2003) whilst others have failed to replicate this (Pell and Leonard, 2005). A recent study by Ibarretxe-Bilbao, Junque, Toloso, Marti, Valldeoriola, Bargallo, and Zarei (2009) using Magnetic Resonance Imaging (MRI) showed that the impairment in the recognition of the facial expression of emotion in those with early Parkinson's disease also have an accompanying bilateral degeneration in the orbitofrontal cortex (OFC) and amygdala.

Lawrence et al (2007) demonstrated how patients with Obsessive Compulsive Disorder (OCD) showed greater activation than controls in the left ventrolateral prefrontal cortex, but reduced activation in the thalamus, to facial expressions of disgust.

Other conditions which show a difficulty with the identification of the facial expression of emotion include Major Depression, Bipolar Disorder, Autism, Attention Deficit Hyperactivity Disorder, Schizophrenia, and Fronto-temporal dementias.

All available test stimuli appear to have some limitations. Furthermore, they frequently show common similarity in errors with participants selecting the wrong identification. Disgust is commonly misidentified as anger, and some confuse surprise for the positive emotion happiness whilst others mistake it for the negative expression, fear (Rosenberg and Ekman, 1995). The commonality among stimuli, where different models are used in each one, suggests that there is a human difficulty in assigning a consistent descriptive label to certain facial expressions of emotion. The emotional state of the participant may have a role to play here. Rosenberg and Ekman (1995) tired to induce an emotional state with short stories when assessing participants' perception of the facial expression of emotion. They found this particularly impacted on the emotions anger, sadness and surprise.

Ricci-Bitti et al (1989) also showed extra-facial cues such as head and eye position may contribute to the identification of the facial expression of emotion. These will inevitably vary among the stimuli batteries and may impact on the results obtained.

It is acknowledged that culture and social learning may have an influence, for instance, in the degree of expression of emotion or indeed in the restriction of its expression, and in the personal or societal interpretation of the emotion particularly when cultural norms indicate whether it is acceptable or not to express (Ekman, 1992). Society would not be able to function in a healthy way if everybody simply reacted automatically to their emotions, and so

on occasion, regulating one's own emotion is crucial. The extent to which an individual can regulate their own emotion is determined partly by age, with older adults reporting they have developed improved control of their negative emotions as they aged (Gross, Carstensen, Pasupathi, Tsai, Götestam-Skorpen, and Hsu, 1997) there being continued advantages into middle age (Rothbart, Ahadi, and Evans, 2000). Despite this, there is an abundance of evidence in support of six emotions and the universality of these emotions (Ekman, Friesen and Ellsworth, 1972; Fridlund, Ekman and Oster, 1987). Ekman and Friesen (1971) further showed that even in a preliterate, stone-age culture, isolated and free from mass media, the tribespersons accurately matched facial expressions with stories depicting the relevant emotions. As further evidence for the universality of emotion these tribespersons were videoed displaying emotions described in the stories previously to them. These videos were subsequently assessed by Americans and the emotions were accurately identified. In a review of the published research from the previous 30 years Ekman et al (1972) showed that there was a great convergence of evidence for six emotions, namely happiness, surprise, fear, sadness, anger and disgust combined with contempt. It is now generally agreed that disgust and contempt are separate emotions (Ekman and Friesen, 1986; Ekman and Heider, 1988).

The importance of socialisation is further emphasised in the study by Bijlstra, Holland, and Wigboldus (2010). These authors aimed to demonstrate the influence of general evaluations and stereotype associations on emotion recognition, and specifically to show evidence for their argument that stereotype associations influence the ease of emotion recognition. They used photographs of two local ethnic groups displaying a facial expression of emotion. One of the groups was the indigenous group, and the other was an immigrant group which was the most negatively stereotyped at that time. They anticipated negative emotions would be quicker to identify in the immigrant group, in-keeping with their negative stereotype image. Their results mean this team are the first to identify that racial or gender stereotype associations may influence the categorization of emotional expressions. This study only used three emotions, namely happy, sad and angry and so there is no knowledge of the influence of stereotype on the recognition of the other basic emotions. Additionally, the vast majority of participants were female (56 out of a total of 64 participants) and there may be an unaccounted for difference between the stereotypical views of women when compared with men which may have skewed the results. Notwithstanding this, the results do show the importance of the ethnicity and gender of the individual posing the facial expression of emotion.

Ekman (1977) proposed two appraisal mechanisms for emotion, one of which he described as automatic and the other extended. He determined that as reaction to an emotion may occur very quickly the initial response must sometimes be automatic and without conscious awareness. On other occasions the response is more deliberate, considered and with cognitive appraisal. Tracy and Robins (2008) showed that overall, emotion expressions can be accurately recognised and discriminated from each other very quickly (i.e. within 600 ms) and under cognitive load.

Vassallo, Cooper, and Douglas (2009) were the first to suggest the orienting of attention to the lower part of the face, especially the nose, appears to differentiate the sexes. Analysis of the scan path revealed that while both groups spent more time and looked more frequently at the eye region, males spent significantly more time viewing the nose and mouth. The duration and number of fixations made to the nose were significantly greater in males ($p<0.5$).

Vassallo et al (2009) were also the first group to show there were reaction time differences between the sexes across a range of universal emotions, which strengthens the role of socialisation. However, the data regarding the role of sex in the identification of the facial expression of emotion has not been consistently shown.

Many studies have used a fixed-choice paradigm when researching the identification of the facial expression of emotion. Russell (1994) criticised respondents lack of ability to use free choice of description arguing that we may see more than one emotion in the face displayed, or perhaps no label suits that displayed and a 'best choice' is made. Izard (1971) had already tried to address this through undertaking a study using a free-response format. The reported results were consistent with those from fixed-choice studies which would add support to the universality of the basic emotions. However, it is important to note the there was no report regarding how the words given in the free-response by participants were categorised. Perhaps those words given were the same adjectives used in other studies, but without knowing this to be so, it makes it rather difficult to evaluate. Furthermore, Rosenberg & Ekman, (1995) postulate that there is actually no need to have a list of adjectives or labels for emotion expressions stating that these are merely methodological conveniences, such is their universality.

Having considered the identification of emotion we shall now move forward to consider neuropsychological explanations for the identification of the facial expression of emotion.

1.4 Neuropsychology as an explanation

As noted above, much of the research into the facial expression of emotion is undertaken by neurological examination. This is undertaken in many forms and has identified many different brain regions as having a role in the processing of the facial expression of emotion.

The orbitofrontal cortex (OFC) has been identified as a crucial structure in the recognition of facial expressions of emotions (Adolphs, 2002a). PET studies have reported activation in orbital regions when recognising facial expressions of emotions**,** and bilateral or unilateral lesions in the OFC may impair emotional face expression identification. However, lesions elsewhere in the frontal cortex (dorsal or lateral) do not appear to impair this function (Herberlein et al, 2008). The amygdala is involved in the recognition of facial expression of emotions (Adolphs, 2002a; 2002b), and mainly in the recognition of fear (Calder et al 1996). Whilst the insula and basal ganglia are implicated in the recognition of disgust (Adolphs, 2002a).

Recent evidence points to neural specificity of disgust reactions in healthy individuals, particularly the ventroanterior and anterior insula (Calder et al, 2007; Mataix-Cols et al, 2008). Mataix-Cols et al. (2008) showed that exposure to disgust images also activated regions associated with emotion regulation, namely the dorsolateral and rostral prefrontal cortices.

Damage to the human amygdala impairs recognition of fearful (and, to a lesser extent, angry) facial expressions (Adolphs et al, 1994; Calder et al, 1996; Broks et al, 1998) while leaving recognition of other basic emotions relatively unaffected. These neuropsychological results are supported by recent demonstrations of a differential neural response in the human amygdala to facial expressions of fear using positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) (Morris et al 1996, 1998; Phillips et al 1997).

Sprengelmeyer, Rausch, Eysel, and Przuntek (1998) showed with functional magnetic resonance imaging (fMRI) that disgusted faces activated right putamen and left insula cortex;

angry faces enhanced activation in posterior right gyrus cinguli and medial temporal gyrus of left hemisphere; fearful faces showed activation in right fusiform gyrus and left dorsolateral frontal cortex. All three emotions also showed activation of inferior part of left frontal cortex. Results support hypotheses derived from neuropsychological findings that the recognition of disgust, fear, and anger is based on separate neural systems, and also that the output of these systems converges on frontal regions for further information processing.

Some authors have argued that the pattern of age differences in the identification of emotion may be related to the pattern of age changes within the neural systems (eg Calder et al, 2003; Isaacowitz et al, 2007; Phillips et al 2002). Tisserand et al, 2002 argue that brain volume losses occur earlier and more rapidly in the orbitofrontal cortex (OFC) than other frontal areas, with brain volume loss and metabolic decline in the anterior cingulate cortex. These areas have been identified as being active in the recognition of anger, happiness and sadness (Blair & Cipolotti, 2000; Phillips et al, 1998; Blair et al 1999). Grieve et al (2005) argue there are some linear reductions in the amygdala volume with age, but there is some sparing of the basal ganglia with age (Calder et al 2003; Williams et al, 2006). The importance of the amygdala has been recognised for some time as important in the processing of fear (Adolphs et al 1994) and sadness (Blair et al 1999).

Neurological studies (mainly fMRI studies and lesion studies) commonly show facial expressions of emotion are associated with activation of the medial prefrontal cortex.
A study by MacPherson, Phillips, & Della Sala, (2002) provided evidence for emotion decoding lying more on the ventromedial area, and working memory more on the lateral frontal regions. In summary, there is further evidence for the negative emotions (particularly fear) being implicated in the amygdala; anger in the anterior cingulate and orbitofrontal cortices; disgust in the basal ganglia and insula; sadness in the subgenual cingulated; and happiness in the ventral striatum and putamen of basal ganglia.

There is accumulating evidence from fMRI studies to suggests limbic and paralimbic regions, including the amygdala, anterior cingulate, and interconnected orbitofrontal and medial prefrontal regions implicated in emotion processing, are also relatively preserved over age (Williams et al, 2008) and so there should be a possibility that those in the older group will perform well.

Perhaps some of the most well-known research into the identification of the facial expression of emotion is that by LaDoux (1994). He postulates that emotions should be studied one at a time because that is how they evolved. He also stresses that emotion systems developed before consciousness and it is only through evolution that we have become aware of our emotions. His work concentrates on the emotion fear. He argues that the brain evolved to allow for decisions about danger to be dealt with in the absence of emotion. When a stimulus occurs, the individual will react in the way it does to danger. There is no need for a conscious awareness, only a response. He suggests that the initial, quick response to fear is in the amygdala via the thalamic pathway. The sound is then relayed from the thalamus to the cortex where cognition and consciousness play their part. An appraisal is then made regarding the fearful stimulus and a decision on how to respond is made.

This theory is likely to have its routes in evolution. An ability to detect and react to a threat would enhance survival, and so this ability would have been selected for, in evolution.

This theory of the role of the amygdala in the emotion fear is supported by numerous neurological studies as noted earlier.

Technology is advancing fast, and perhaps the more technology is able to explore the different brain regions involved in the processing of the facial expression of emotion, the more mystifying it will become. That we are able to pinpoint with apparent reasonable accuracy which areas of the brain are activated when processing a particular emotion is exciting, but perhaps a two-edged sword. It is unlikely that any one small brain region is acting alone, but the technology is not yet sophisticated enough to identify, and highlight, the links to other brain regions, such as that between the amygdala and thalamus.

Whilst there are undoubtedly neuropsychological explanations for the identification of the facial expression of emotion, there must also be social neuropsychological explanations as emotion recognition is said to impact greatly on an individual's social abilities. We shall now consider one such theory, the socioemotional selectivity theory and positive bias.

1.5 Social neuropsychology bias (Positivity bias) as an explanation

As noted above, research has consistently shown that older adults have difficulty, to varying degrees, in identifying negative emotions.

Whilst neuropsychology may propose some explanation, the socioemotional selectivity theory offers a different explanation. Carstensen (1992) proposes the age differences in the perception of the emotion displayed may depend upon the valance of the emotion.

It has been noted that as a population ages they have a different approach to life. They are shown to have fewer incidences of anxiety and depression, and frequently older people are shown in longitudinal studies to have less negative affect as they age (Weissman, Leaf, Bruce and Florio, 1988; Charles, Reynolds, and Gatz, 2001). Converging support for changes in aging adults is offered by Carstensen, Pasupathi, Mayr and Nesselroade (2000). They showed that aging adults experience fewer daily incidences of negative emotions until age 60 years by which time it levels off, whilst Mroczek and Kolarz had previously shown in 1998 that there are modest increases in positive emotion from middle age to early old age.

In 1992 Carstensen proposed a socioemotional selectivity theory and she continues to develop this further. Essentially, she advocates that, as an individual ages, they will experience life differently. As they become more aware of, and focus upon time they will increasingly be motivated to derive emotional meaning from life and less motivated to expand their horizon. They increasingly attend to the emotionally meaningful goals in their lives and become more adept at regulating their own emotions. This ability to regulate their emotions, and emotional responses, offers further support to Ekman's (1992) theory of not always making an automatic appraisal of emotions. If the older adults orientate towards positive emotions and disregard the negative emotions, some cognitive appraisal must have occurred in order to make the more extended appraisal result in positive emotionally meaningful goal-directed behaviour. Additionally, this may explain the research which demonstrates the older person's inability to label the explicit presentation of emotions but behave appropriately.

The socioemotional selectivity theory also emphasises the role of social contact in the processing of emotion. Through a process of continuous self-regulation, Carstensen, Fung, and Charles (2003) propose that the aging adult will deliberately choose to concentrate on the

pursuit of emotionally meaningful goals. This, they suggest, will involve the aging adult in behaving in a way that will make them feel good, and satisfaction with this feeling reinforces the behaviour. In essence, the subjective state is the reward for the behaviour and so is self-perpetuating.

Older adults have an ever-decreasing social circle, often through the death of their peers and family members, but also, when compared with young adults, they are less likely to seek out new companions to replace those lost. Carstensen (1992) suggests they tend to increase the importance with which they hold their relationships with family and long-term friends, to the exclusion of an opportunity to increase their social circle. Often, if goals compete with each other the older adult will concentrate on the more emotionally meaningful goals. Therefore, where investing in a new friendship risks negative emotional consequences (even something such as anxiety), this will be disregarded as it would not be seen as a beneficial investment of their time (Carstensen et al, 2003) when there is a known positive emotional benefit to investing in those already close.

This loss of friends and family also strengthens the feeling of time passing by quickly for the older adult. Lang and Carstensen (2002) demonstrated a linear trend for adults aged 20 to 90 years in which the older adults foresee a more limited future, irrespective of health status. Whilst younger adults foresee time as almost limitless and set their goals in accordance with this, the older adult foresees their future as limited with fewer opportunities open to them. This, Carstensen et al (2003) hypothesise, can be demonstrated by a curvilinear path whereby the trajectory can be highest in infancy and early childhood when emotional trust is established, and rises again in older adults when the future is perceived as limited. The future no longer becomes an important consideration to the aging adult, but the present does. Time is perceived as running out. These motivational shifts affect cognitive processing (Isaacowitz, Charles, & Carstensen, 2000).

In addition to the social pruning for positive effects, the socioemotional selectivity theory also supports that older adults when compared with younger adults, disproportionately remember positive information, including autobiographical memories.

The socioeconomic theory proposes that younger adults pay less attention to the emotional valence because (if healthy) they do not see time being a restraint to achieving goals.

Carstensen et al (2003) consider that their needs for knowledge-related goals take prime consideration and they even go so far as to state that they pursue these knowledge-related goals relentlessly at the cost of emotional satisfaction.

Support for the pursuit of positivity may be evident in research which has shown that older adults tend to reappraise negative expressions in a more positive light. They also tend to focus on mouths which are less threatening but less informative for negative expressions, whilst younger adults spend more time looking at the more informative eye regions of negative expressions (Sullivan et al, 2007; Wong et al, 2005).

The age-associated changes in social network composition, and the emotional experience derived from social interactions, suggest that older adults structure their social worlds to optimise emotionally meaningful, and therefore gratifying, experiences and to avoid potentially negative interchanges. Age-related reductions in social contact have been widely documented in both longitudinal (Lee & Markides, 1990; Palmore, 1981) and cross-sectional studies (Cumming & Henry, 1961; Lawson, Moss & Fulcomer, 1987). Older people interact less with others and appear to resist efforts by others to make new friends (Carstensen, 1986).

In summary, the socioemotional selectivity theory is the assessment of time left in life that drives a shift in emotion-related goals. As endings approach and concerns about the future decrease, knowledge-related goals lose importance. In contrast, an increased present orientation emphasises goals related to emotional satisfaction and meaning. This age-related motivational shift leads to alterations in the dynamic interplay between individuals and their environments such that optimisation of emotional experience is prioritised in later life.

Some consideration also needs to be given to the possibility of general cognitive difficulty in the aging individual, and will be briefly covered in the next chapter.

1.6 General cognitive difficulty as an explanation

When taking into account the general cognitive difficulty as an explanation, one would consider the general cognitive decline seen in the aging adult. It could be postulated that an age effect would be seen and would be greatest on the emotions that are most difficult to identify. However, Calder et al 2003 argue that difficulty effects do not represent a viable

interpretation because they found no age effect on disgust, which is a relatively difficult emotion to identify. In addition to this, one would have to consider the relationship between IQ and the dorsolateral corex, and emotion and the ventromedial cortex. It is not proposed to consider this theory for this study as all adults in the older group will undertake an examination to exclude cognitive decline.

The aim of this study is to investigate whether the implicit processing of emotions is spared in older adults compared to explicit processing.

It is hoped that this study will demonstrate that older adults are implicitly aware of both negative and positive facial expressions of emotion. It is expected that, in-keeping with other research, the older adults will not perform as well as the younger adults in labelling the explicit facial expression of emotion. It is also expected that social contact will act as a modifying factor in the correct identification of the facial expression of emotion in the explicit identification task.

This research is important because much of the work establishing difficulties with emotion labelling is undertaken with those with psychiatric and neurological disorders and they may also have impaired cognitive functioning. Research with a healthy-aging older population will be informative.

The ability to appraise the facial expressions of emotion is a key component of social cognition. If those in the older group *are* able to implicitly label emotions, further studies could help to gain an understanding of what interferes with this post-labelling.

The results will also be considered for developing further research on the older adults' ability to detect leakage of micro-expressions, and how this relates to them being more easily deceived.

Methodology

2.1 Ethical approval and consent

Ethical approval for this study was sought from, and granted by, the University of Edinburgh's Philosophy, Psychology & Language Sciences Research Ethics Committee. Informed written consent was obtained from each participant.

2.2 Design

This study was a repeated-measures design in which the independent variable for both tasks was age of participant (with two levels: younger (18-40 years) and older (60-80 years)). The dependent variables for the implicit task were the number of errors made (out of a maximum of 150) and the reaction time, and only the number of errors made (out of a maximum of 60) in the explicit task**.**

2.3 Participants

Individuals aged 18 to 40 years and 60 to 80 years were invited to participate from the University of Edinburgh Student Participant Pool, and the University of Edinburgh Psychological Research Participant Pool respectively. Those recruited from the Student Participant Pool received course credits. Those recruited from the Psychological Research Participant Pool received a small monetary remuneration for any expenses they may have incurred. All were invited to participate in a study considering the effect of age on the processing of faces, and were not told at this point that it was a study specifically relating to the processing of the facial expression of emotion. They were however, made aware of this at the end of the study and an opportunity was given to each to discuss any concerns they may have had by not being fully informed from the outset. No-one expressed any concern regarding this.

Following a successful pilot study, 51 participants were recruited to the study over a two week period. Participants aged 18 to 40 years were allocated to the "younger" group, and those aged 60 to 80 years were allocated to the "older" group. All participants in the younger group were recruited from the Student Participant Pool following an on-line advert for the research study. Recruitment was sequential. Technical difficulties with the randomisation of sequencing for the implicit task resulted in 11 participants' data being excluded from the

analyses, and three participants' data was excluded because although educated in the English language, English was not the first language. This resulted in 18 participants' data within the younger group being used for all analyses. All participants from the older group were recruited in sequential order from responses to an e-mail inviting participation. 19 participants were initially recruited to the older group. One participant had difficulty with the Benton Facial Recognition Test, scored below the "normal" score range, and is therefore not included in the study. Therefore, data for a total of 36 participants is included in the analyses.

All participants had normal or corrected to normal, vision and stated that nothing contained within the exclusion criteria applied to them.

The mean age for those participants in the younger group was 19 years (range 18-20 years), and the mean age for those allocated to the older group was 67 years (range 61-75 years).

All participants were Caucasian. Overall, 64% of participants were female and 36% male. Overall, 86% of participants were right handed and 14% were left handed. Further demographic and behavioural measures are noted in Table 1.

2.4 Materials

2.4.1 Benton Facial Recognition Test

All participants were asked to undertake the short form of the Benton Facial Recognition Test (BFRT), as an assessment of face recognition abilities. This test has extensive normative data (Benton, Sivan, Hamsher, Varney, and Spreen, 1994). All photographs in the BFRT are black and white, male or female models, each with some hair but no clothing visible. There are two forms of the BFRT. The short form version, with 13 items, has a possible maximum score of 27 points, whereas the long form version, with a further nine items, has a maximum possible score of 54 points. For the first six items, Participants were presented with a target face above six test faces. They were asked to indicate which of the six test faces identically matched the target face (all test faces are numbered). For the remaining seven items, Participants are asked to identify which three of the six test faces matched the target face. The test faces are taken from differing angles and with differing lighting to those of the target face. No time limit is applied to undertaking the test, and it does not rely upon memory. Using the Table on the record form, the short-form score was converted to a long-form score. Those in the older

group were eligible for additional points depending upon their age and years of education. The Corrected Long Form Score is reported, from a possible maximum score of 54. A score of 41 or more is considered "normal". Results are noted in Table 1.

2.4.2 Wechsler Abbreviated Scale of Intelligence

All participants undertook the Wechsler Abbreviated Scale of Intelligence (WASI) subset consisting of the Vocabulary and Martix Reasoning tasks. Tasks were administered in that order as recommended in the WASI manual. The test resulted in a measure of the Full Scale IQ-2 (FSIQ-2). The WASI is a short and reliable measure of intelligence in the research setting, and is standardised, normed, and validated for those aged 6 to 89 years. The Vocabulary subtest consists of a 42-item task. The first four presentations are pictorial and the Participant was asked to name each of the pictures. The other 38 are orally spoken and visually presented words and Participants were asked to orally define them. This test is a measure of crystallised intelligence. The Matrix Reasoning subtest has a series of 35 incomplete gridded patterns with a choice of five possible pattern answers. The Participant was asked to state which of the five they think the answer is. This subtest is a good measure of nonverbal fluid reasoning. The two described subtests estimate general cognitive functioning (The Psychological Corporation, 1999). The subtest raw data scores were converted to age corrected *T* scores and the final FS2-IQ score is reported. Results presented in Table 1.

2.4.3 Addenbrooke's Cognitive Examination (ACE - R)

All participants age 60 years or older were asked to complete the ACE-R Final Revised Version A (2005). This battery of tests examines memory, verbal fluency, language, visuospatial abilities, attention and orientation. The test is a dementia screening tool with a possible score range of 0 to 100. It is sensitive to isolated frontal deficits (Lezak, 2004). Normative values suggest a cut-off of less than 88 gives 94% sensitivity and 89% specificity for dementia, and a cut-off score of less than 82 gives 84% sensitivity and 100% specificity for dementia. Results are presented in Table 1.

2.4.4 Social Contact

Using a survey developed by the researcher all participants were asked about the type and frequency of social contact they had, on average, with various individuals. These individuals included (where appropriate) grandparents, parents, partner, siblings, children, grandchildren,

close friends and distant friends. Where applicable, they were then asked to indicate whether, overall, they thought this amount of contact was 'not enough contact', 'too much contact' or 'just about right'. Results are presented in Table 2.

2.4.5 Stimuli

The experimental tasks were created and presented using E-Prime® 2 (Schneider, Eschman and Zuccolotto, 2007).

Visual Stimuli – NimStim©

Permission was sought and granted to use photographs from the NimStim battery as stimuli in this study. This battery was chosen, not only on the basis of its validity and reliability, but because it had never been used before with the research Participant Groups in the University of Edinburgh Department of Psychology. Other batteries have been used frequently and there was therefore a possibility that had any participant taken part in similar research, the results may be affected by familiarity of the stimuli. Hopefully is using this new battery, this will have been avoided..

All photographs in the NimStim battery are in colour, naturally posed, of the head only, frontal pose, with clear background and no visible clothing.

The original set consists of 43 professional actors and actresses displaying 672 faces. There is a wide ethnic diversity, and in addition to the basic six emotions, a neutral expression and calm expression are included. 76% of the emotions were rated with an average reliability score ranging between 0.80 and 1.00 (Tottenham, Tanaka, Leon, McCarry, Nurse, Hare, et al, 2009).

For this study, five male and five female Caucasian individuals were chosen which reflected the participants own race or ethnicity. Each of the ten individuals displayed each one of six emotions – happy, sad, angry, frightened, disgusted and surprised. Therefore a total of 60 different photographs were displayed. This set includes emotion displayed with an open or closed mouth.

2.4.6 Implicit Task

The first task, the implicit task, consisted of two phases - a practice phase and a test phase, with a forced choice response. The test phase was further broken down into two blocks to minimise fatigue, particularly with consideration for the older group. The practice phase consisted of the presentation of six target photographs presented in a randomised order. Each emotion was presented. The test phase consisted of two similar blocks. In each block, 75 faces were presented as the prime face, in a randomised order. Each face demonstrated one of the six emotions. Each block consisted of all 10 stimuli individuals. After the presentation of the first block, the screen displayed a message asking the participant to take a break and to then press the space bar when ready to resume the task.

A fixation point (+) was displayed in the centre of the screen followed by a prime face. This would be presented for 30 milliseconds, and then replaced by the fixation point. Two photographs of the same individual presented as the prime would then be displayed, side by side on the screen. One of the photographs was that used as the prime, the other was the same individual but displaying a different emotion. Participants were asked to indicate which of the two photographs now presented, matched that shown quickly. They made their choice by means of striking a key on the left of the keyboard coloured blue if they thought it matched the photograph displayed on the left of the screen, and by striking a key on the right of the keyboard coloured red if they thought the prime photograph matched that now presented on the right of the screen. Participants were informed accuracy and reaction times were being measured. Once a choice had been made, the two photographs were replaced by a fixation point and a further prime photograph was then presented.

Participants did not receive any feedback on their performance.

2.4.7 Explicit Task

The second task, the explicit task, consisted of two phases – a practice phase and a test phase.

Stimuli in the practice phase consisted of six consecutive, but randomly presented, photographs of one individual. Each photograph displayed one of each of the six facial expressions of emotion. Below each face were six adjectives namely, happy, sad, angry,

frightened, disgusted and surprised. The six adjectives were always presented in the same order, in the same position on the screen.

The test phase consisted of one cycle of a randomised presentation of all 60 photographs each with the six adjectives as described above, displayed below the face.

Participants were instructed that their task was to decide which adjective best described the emotion displayed by the individual on-screen. They indicated their choice by pressing the appropriate letter on a keyboard, as specified on a large instruction sheet always displayed above the keyboard, and below the computer screen, and on-screen. Participants were informed accuracy was being measured. The photograph would remain on-screen until the Participant had made a choice. Participants did not receive any feedback on their performance.

Both the implicit and explicit tasks were first trialled on a number of younger and older adults whose scores are not used in the analyses.

Limitations of This Study and Considerations

There are some limitations to this study, the first being, although age effects were noted, there was a small number of participants recruited to each group.

Ecological validity cannot be assured as static photographs were used, and perhaps different results would have been obtained if the presentation was more dynamic, perhaps including body movement and verbal tone.

Whilst younger adults did not perform at ceiling and older adults performed at better-than-chance, lessening the exposure time may make the implicit task more difficult and it may be possible to get a truer implicit response. However, based on the experience of the participants in this study, it could be anticipated that any gains would be offset by an increase in the older adult anxiety.

Some older adults displayed anxiety when undertaking the implicit task, but all said they had enjoyed the task, found it very interesting and would consider undertaking it again. It was not possible to take account of any possible effect on performance this increased anxiety may have had.

It was noted that some older adults appeared to show a lack of concentration. Indeed, many talked through the test phase and some actually admitted to loosing concentration. Perhaps the test phase was too long for them. However, reducing this may affect results.

Finally, older adults seemed to be less confident in their keyboard skills, and perhaps they would have preferred being able to offer a verbal response.

Possible Future Developments

When considering possible future developments, in the implicit task one should perhaps contemplate simply showing one photograph after the target face and asking if it is “the same or different”.

Additionally, as a control implicit task, perhaps photographs of scenery could be used. Ruffman, Sullivan, & Edge (2006) showed younger and older adults did not differentiate in their response to non-face stimuli such as photographs of sporting activities or occupations.

Finally, after excluding speech difficulties, it would be interesting to consider a means of verbal response rather than keyboard.

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